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Studies on Peculiar Distribution Pattern of *Callimico*

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Abstract. The geographical distribution of *Callimico* is between the Río Caquetá in southern Colombia as its northern limit and the Río Orthon and Río Manuripi in northern Bolivia as its southern limit. Being small in numbers in this range, it lives in groups which maintain long distances between each other. The author considers such a pattern of distribution as peculiar to this species of monkey. *Callimico* inhabits "shabby" forest, such as second-growth wood, bamboo forest, and forest whose canopy is discontinuous, so that scrub grows well, and those in further inland areas. The ecological and behavioral peculiarities of *Callimico* appear to represent adaptations to life in such "shabby" forests.

The habitat of *Cebuella*, whose distribution covers the same range as *Callimico*, is also the "shabby" forests, but is located at the forest edge. *Callimico* and *Cebuella* are thus segregated between the inland areas and forest edge, respectively.

Five species of *Saguinus* are also found in the same range, of which *S. fuscicollis* occurs sympatrically with any one of the other four species. *Saguinus* tends to inhabit rather the mature forest but often utilizes the "shabby" forest also. It may represent a good competitor of *Callimico*.

Examination of the relationships between *Callimico* and callitrichid monkeys from the phylogenetic evolutionary viewpoint indicates that *Callimico* came to adopt its present pattern of distribution as a result mainly of decrease in "shabby" forest in the upper Amazon basin and of competitive relationships between *Callimico* and *Saguinus fuscicollis* which enlarged southward its inhabited range from the north, where it may originally have made speciation.

INTRODUCTION

The present author made six ecological surveys of New World monkeys in Colombia, Peru, and Bolivia over the eight years from 1971 to 1978. He had intended to include *Callimico* in all these surveys, but was not able to observe it satisfactorily. Compared with the other species of monkeys studied, confirmation of even its existence was difficult. As the main purpose of the fifth and sixth surveys, therefore, the most suitable localities for studying *Callimico* were sought, and it was in the sixth survey that the author directly observed it for the first time.

Based on the above twice surveys, two most suitable localities were found, one on the right bank of the upper Río Blanco basin, a tributary of the Río Tapiche in Perú, and the other on the left bank of the Río Nareuda, a tributary of the Río Tahuamanu in Bolivia, where intensive surveys will be made in the near future. It become apparent

that the pattern of distribution of *Callimico* was significantly different from that of other species of New World monkeys.

The present paper describes the inhabited range of *Callimico* found through the above surveys, and analyses its present state of distribution in the range and ecology. The peculiarity of the distribution pattern of *Callimico* as compared to that of *Cebuella* and *Saguinus*, both of which inhabit sympatrically with *Callimico*, and the question of why *Callimico* has adopted such a pattern of distribution, are also discussed.

RESULTS AND DISCUSSION

Distribution of *Callimico*

Hershkovitz (1977) has hypothesized from various available data that the distribution of *Callimico* is "the upper Amazonian rain forest, hypothetically between the Río Madre de Díos-Río Madeira in the south, the Caquetá-Japurá in the north, and the Andean foothills in the west." Utilizing the literature on *Callimico*, Izawa (1977c) plotted the identified localities on a map, and found that they agreed with Hershkovitz' hypothesis. Hershkovitz has also suggested the possibility from information

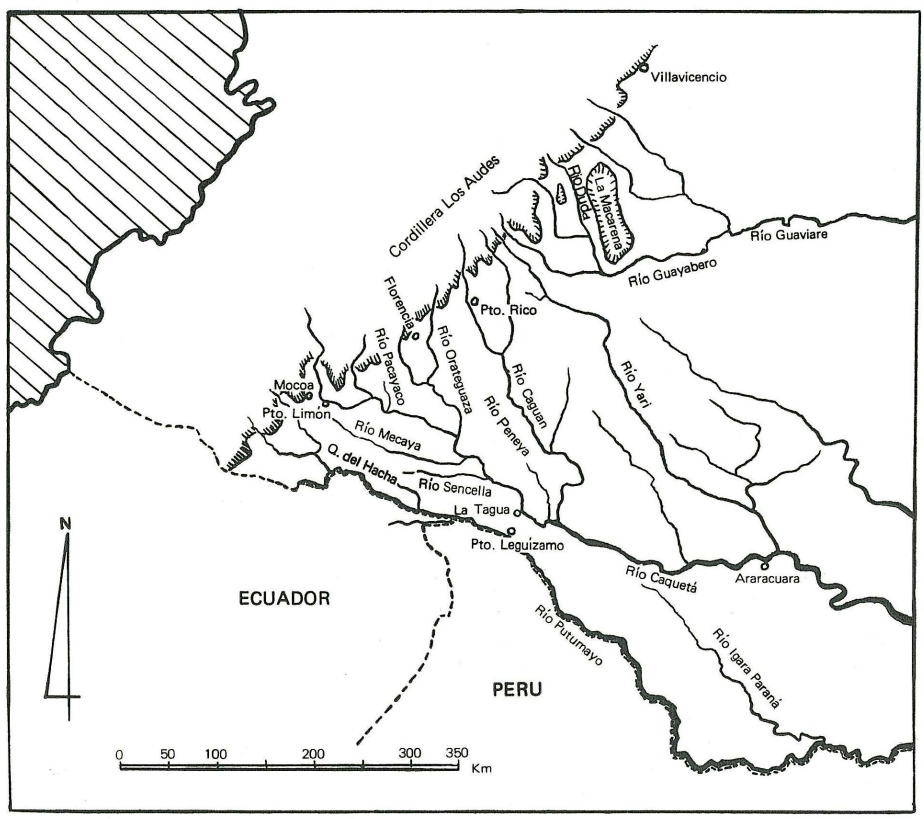

Fig. 1. Map of southern Colombia, where the author surveyed.

suggesting that *Callimico* inhabits the upper Río Catatumbo in northern Colombia. However, that seems doubtful.

The northern limit of distribution apparently lies between the Río Putumayo and the Río Caquetá according to Hershkovitz (1977), Moynihan (1976a), and Hernandez-Camacho and Cooper (1976). During his survey in Quebrada del Hacha on the north bank of the Río Putumayo in October 1971, the present author also obtained authentic information from the local inhabitants that *Callimico* inhabited there. Also, Mr. Tsuyoshi Watanabe of Kyoto University again made a survey there in December 1976 which yield similar information.

The author made surveys to determine whether *Callimico* inhabits the north bank and further north of the Río Caquetá (Fig. 1). These comprised 1) inquiries from the mouth of the Río Orteguaza to Florencia twice in January 1972 and in February 1974, 2) inquiries from La Tagua to Pto. Limón in the basin of the main stream of the Río Caquetá in January 1974, 3) inquiries from La Tagua to the mouth of the Río Yarí in the basin of the main stream of the Río Caquetá in August 1973, 4) a survey in the lower basin of the Río Yarí in September 1973, 5) inquiries from the mouth of the Río Caguan to Pto. Rico in October 1975, 6) long-term surveys in the basin of the Río Peneya and its environs from 1971 to 1976, and 7) long-term surveys in the Río Duda basin, a tributary of the Río Guayabero further north of the Río Caquetá from 1975 to 1978. Inquiries were also made in the Río Guayabero basin. However, no evidence of information was obtained to suggest that *Callimico* inhabited the above areas.

In this light, it can be safely said that the distribution of *Callimico* borders on the

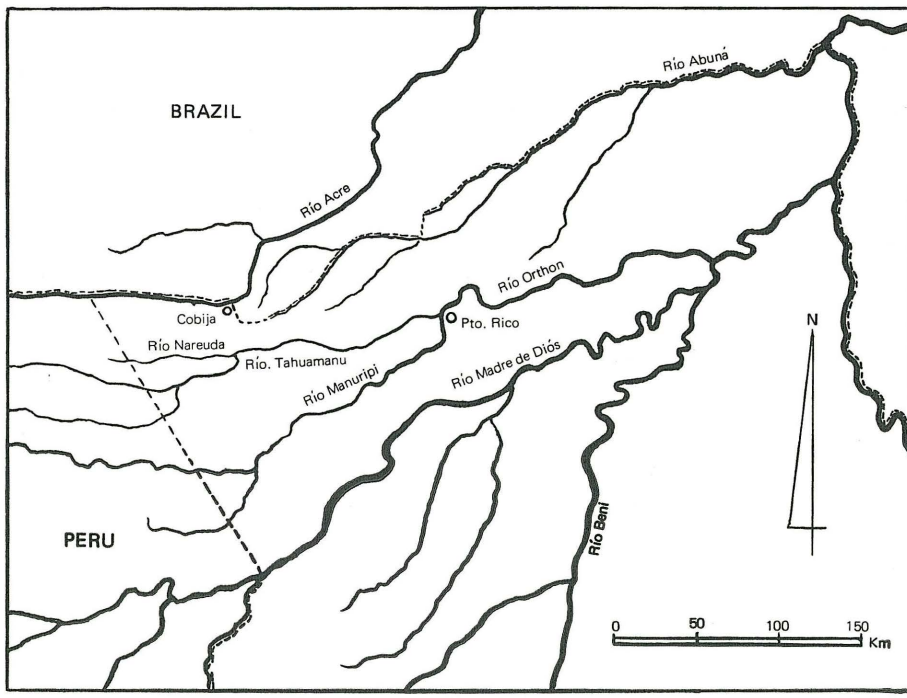

Fig. 2. Map of northern Bolivia.

main stream of the Río Caquetá in the north. Moreover, as discussed below, it became apparent that the northern limit of distribution of *Cebuella* was also the Río Caquetá. These findings for *Callimico* and *Cebuella* agree with the data of Hernandez-Camacho and Cooper (1976). However, the distribution of *Ateles*, being different, might exclude the south bank of the upper Río Caquetá at least from its head to Araracuara. The distribution of *Saguinus* which they reported is perhaps open to discussion.

The author made various inquiries to determine the southern limit of distribution of *Callimico* in September 1978. The results indicated that *Callimico* inhabits 1) both banks of the Río Acre, 2) both banks of the Río Tahuamanu, and 3) the north bank of the Río Manuripi but not its south bank. Information obtained on one occasion by hearsay did indicate that *Callimico* may inhabit the vicinity of Pto. Ríco on the south bank of the Río Orthon. However, aside from this dubious information, it may be said that in the south the distribution of *Callimico* borders not the Río Madre de Diós as hypothesized by Hershkovitz (1977) but the rivers next to the north, i. e., the Río Orthon-Río Manuripi (Fig. 2).

The present author has no new data regarding the eastern and western limits of distribution of *Callimico*. However, it is anticipated that in the west it borders on the Andean foothills as described by Hershkovitz (1977) and in the east does not extend beyond the localities bordering on the northern and the southern rivers which meet the main stream of the Río Amazon.

Present state of distribution of *Callimico*

Callimico occurs as a small population in the above-mentioned areas, and so lives in groups which maintain long distances between each other. It is difficult to this pattern of distribution to human influences such as breakdown of the forest and strong hunting pressures. On plotting localities at which the presence of *Callimico* was confirmed, Izawa (1977c) deduced that the population numbered 15. Moreover, even if localities suggested by Hershkovitz (1977) and new personal information are taken into account, the total number of localities where *Callimico* might inhabit does not amount to twice as many as 15. This suggests a strong difference from all other species of New World monkeys living in the upper Amazon basin, including large body-sized species such as *Ateles* and *Lagothrix*. The plotted localities of each species of other New World monkeys would overlap onto one another and would cover most of its inhabiting range.

The reasons why this peculiar distribution pattern cannot be accounted for by human influences may be summarized as follows: 1) There is no historical evidence of Indios hunting or eating *Callimico* specially: they could hunt larger-sized and more tasty monkeys such as *Lagothrix* and *Ateles*. 2) There is also no evidence of their hunting *Callimico* for medical purposes. 3) There is no evidence of their using *Callimico* for special peculiar purposes such as in religious ceremonies. 4) There is no record to indicate that appreciable numbers of *Callimico* were captured following the advances in capturing methods made during the past one or two centuries: on the contrary, available records indicate that extraordinarily small numbers of *Callimico* were captured (Green, 1976; Muckenhirn, 1976; Moro, 1977; Castro, 1977). 5) It is impossible to envisage that any large-scale breakdown of the forest in recent years has exerted a strong influence only on *Callimico*.

Based on his own field work over a period of 11 years in South America, and on information received, Hershkovitz (1977) has put forward a suggestion similar to the author's, that *Callimico* has "a low population and a thin or scattered distribution, at least in Perú, Colombia, and no doubt Ecuador and Bolivia." As to the reasons behind this suggestion, he mentions that in comparison with callitricids, *Callimico* 1) produces only one young, 2) travels in small groups, 3) has dark, shadowy figure and behaves placidly, 4) may be partially nocturnal, 5) has a predaceous habit, etc. However, the first three of these reasons would not discourage native hunters or leading primate-ecologists. In fact, *Pithecia* which is slightly different in size but has characteristics similar to those of *Callimico*, can be easily observed and native hunters could locate it without difficulty. As to reason 4), should this be true of *Callimico*, it appears hardly to constitute a valid reason if one takes *Aotus* into consideration, since native hunters could readily capture this animal. Strong electric torches may help researchers at least in locating *Callimico*. Finally, compared to other species of New World monkeys (e.g., *Cebus* and *Saimiri*), there is no evidence to suggest that *Callimico* is extraordinarily predaceous. Moreover, it is rather impossible to regard the difficulty in finding *Callimico* in the same light as that experienced with small felids, since these tend to live alone in the forest floor.

Based on the above arguments, it thus seems reasonable to regard that the pattern of distribution of *Callimico*, one in which the groups maintain long distances between each other, as peculiar to this species of monkeys.

According to Hershkovitz (1977), Moynihan (1976a), Hernandez-Camacho and Cooper (1976), and information given to the author by Dr. Federico Medem of the National University of Colombia, Villavicencio, Dr. Jesus M. Idrobo of the National University of Colombia, Bogotá, and Mr. Pekka Soini of the Ministry of Agriculture, Iquitos, it appears that at least in Colombia and Perú, only one or a few groups of *Callimico* consisting of about five individuals inhabit each locality maintaining long distances between each other. This must be the reason for the difficulty experienced by the author in finding *Callimico* in his surveys.

However, the author was able to gain much useful information during a survey in the Río Tapiche, Perú, in February 1978. It was found that *Callimico* occurs as a relatively high population from the head to the upper basin of the Río Blanco, a tributary of the Río Tapiche. In fact, the inhabitants of these localities were familiar with *Callimico* and called it by native names such as "chorro pichico," "pichico chovon," except common Spanish names "pichico negro" or "supay pichico". This also seems to be true from the head to the upper basin of the Río Tapiche (Izawa, 1978b.)

Another locality where *Callimico* is found as a relatively high population is the Río Acre basin in northern Bolivia, which the author surveyed in September 1978. *Callimico* is never a rare species of monkey there like *Saguinus labiatus, S. fuscicollis,* and *Cebuella,* all of which exist sympatrically. In fact, most of the inhabitants have seen it several times. The author obtained similar information on *Callimico* also from the north bank of the Río Acre within Brazilian territory (Izawa, 1979a).

Excluding these localities in Brazil, which the author has yet to survey, *Callimico* has been confirmed to inhabit with a relatively high population only two exceptional localities among those surveyed by the author.

Vegetation of localities where *Callimico* was confirmed

Some literature exists on the vegetation of the localities in Colombia where *Callimico* was confirmed to occur. Moynihan (1976a) reported that the individuals he observed lived "in mixed forest and scrub, mostly low and young second growth, possibly five to ten years old, on a poor drained island in the Río Guineo" at the head of the Río Putumayo. He added that "the vegetation of the island is extremely dense and rather varied for its apparent average age. It is further diversified or interrupted by a few large native trees, presumably relicts of an earlier forest, many stands of imported Asiatic giant bamboos, and occasional plantations." According to Hernandez-Camacho and Cooper (1976), the vegetation at three collecting localities of three specimens in the lower Río Guamués, Quebrada del Hacha, and Río Igara-Paraná consisted of "nonflooding forest, either level or with low rolling hills." On the other hand, Dr. J. Idrobo, who had studied the vegetation of the Río Igara-Paraná, stated that the collecting locality was in the upper basin of the river where hills stretched upwards and the vegetation was rather different from the typical one of the Amazonian plain lowland, i.e., mature forest; a kind of bamboo, *Bambusa guadua* and well-developed scrub were included (pers. comm.). At the collecting locality in Quebrada del Hacha, a small river, many patches of bamboo, and well-developed scrub were found (T. Watanabe, pers. comm.). The author studied the vegetation of Araracuara, in the middle Río Caquetá basin, where Dr. F. Medem had informed him that *Callimico* occurred, and found that it consisted of bush or grassland on the mountain summits and of poor forest and well-developed scrub in the intervening valleys of the mountain masses.

Fig. 3. Bamboo forest, a kind of "shabby" forest, along a stream of the Río Nareuda.

Table 1. Vegetation of localities where *Callimico* was directly encountered by inhabitants in northern Bolivia.

Vegetation	Number of localities*
Mature forest	0
"Shabby" forest	
Bamboo forest	31
Well-developed scrub on the periphery of bamboo forest	4
Second-growth woods adjoining plantations	1
Second-growth woods 15–20 years after being abandoned	1

*Since the cases in which one group was encountered more than twice in different places are included, the data do not indicate the number of *Callimico* groups.

Concerning the vegetation of the localities in Perú where *Callimico* was confirmed to occur, Mr. P. Soini provided information that tall trees did not cover the forest canopies and scrub was well developed at Quebrada Tocón in the Río Nanay basin, where he had directly observed *Callimico* (pers. comm.). In the upper Río Blanco basin, where the mountains undulate, the author observed that bamboo with spines, apparently a kind of *Bambusa*, formed patches along the valleys, and scrub was also well developed. The heads and upper basins of the Río Blanco and Río Tapiche correspond to the foothills of the mountain masses which form a watershed between the Río Ucayali and the Río Juruá. The author has heard that *Callimico* inhabited the east slopes of the mountain masses within Brazilian territory (Izawa, 1978b.)

In Bolivia, well-developed bamboo (*Bambusa* sp.) forests with a width of 10–40 m extend along such streams as the Arroyo Buenos Aires and the Arroyo Infierno joining the Río Acre on its south bank (Fig. 3). Almost all of the localities where *Callimico* was confirmed to exist were situated in such bamboo forest or on its periphery. The vegetation of the basins of streams joining the Río Tahuamanu on both its banks, where *Callimico* was confirmed is similar. Both localities consisted of rather plain lands. During the survey in Bolivia in September 1978, the author was guided by the inhabitants to as many as 37 localities where *Callimico* had been encountered directly by them. The vegetation of these localities is shown in Table 1. The author also obtained reliable information that *Callimico* inhabits the north bank of the Río Acre within Brazilian territory, where bamboo forests are well developed.

Concerning the habitat of *Callimico*, Hershkovitz (1977) has stated that "Judging by the rarity of encounters, individuals seen in second-growth woods along roads, streams, clearing, or near houses are probably wanderers from the interior forest." The interior forests he described might consist of typical Amazonian and undamaged tropical rain forests (mature forests), where stretches of tall trees form forest canopies, and secondary and under-growth show scanty development. However, as mentioned above, *Callimico* never or rarely inhabits such forests according to the author's findings. It can be concluded therefore that the habitat of *Callimico* consists essentially of the second-growth woods as described by Hershkovitz, or of places similar to them, e.g., bamboo forests and certain kinds of forests with discontinuous canopies and with well-developed scrub. The author designates the forests which characterize the habitat of *Callimico*, no matter whether they are natural or human-influenced as the "shabby" forests (Izawa, 1977c, 1978c). Furthermore, it is worthy of note that, based on the information and literature available to date, the "shabby" forests where *Callimico* has been confirmed to occur are not those generally seen along rivers

with a width of several hundred meters and large rivers with a width of several kilometers, but those found along smaller rivers with a width of several tens of meters at most and streams with widths of a few meters to some dozen meters.

Ecology of *Callimico*

Food: According to information given to Moynihan (1976a), "*Callimico* eats insects and berries like other tamarins," and "*Callimico* may take more vegetable matter than most of the other tamarins under natural or seminatural conditions" in Colombia. However, the author was unable to obtain any further information on the feeding habit of *Callimico* in Colombia.

Inhabitants of the upper Río Blanco basin in Perú who had directly watched *Callimico* informed the author that it ate mainly insects, spiders, and berries of scrub plants in the lower layer of the forest, and sometimes it approached tall trees to eat their fruit.

Similar observations were described by inhabitants of the basins of the Río Acre and the Río Nareuda, a tributary of the Río Tahuamanu, both of which are in Bolivia. Starting ecological surveys of *Callimico* in September 1978 in the Arroyo Buenos Aires, a tributary of the Río Acre, Drs. George Pook told the author that *Callimico* ate fruit of *Cecropia* sp. and resinous matter which oozed out from the bean pods of tall trees (Mimosaceae) (pers. comm.). In fact, the author also observed *Callimico* eating fruit of *Cecropia* sp. during his two-day stay at the study site. He further found it searching for something, probably insects, at the joints of epiphytes and hollows on secondary growths in the early morning (6:11–6:50 a.m.).

While a detailed report on the feeding habits of *Callimico* in Bolivia can be expected from Drs. Pook, it seems sure at least that insects and fruit constitute its main foods. Similar feeding habits may also apply to the *Callimico* living in Colombia and Perú. This means that unlike *Cebuella* (see below), *Callimico*'s diet may not be specialized.

Sleeping sites: No information or reports exist on the site occupied by *Callimico* when sleeping in the wild. In Bolivia, the author observed a group of *Callimico* emerging from the foliage of wood vines covering a tree (about 15 m) in the early morning (6:11 a.m.), at which it was thought to have remained throughout the night.

The species of New World monkeys which utilize such trees as sleeping sites include *Cebuella* in Bolivia, as observed by the author, and *Cebuella, Saguinus mystax,* and *S. fuscicollis* in Perú, as observed by Mr. P. Soini (pers. comm.). It can thus be safely said that the utilization of heavy-foliaged and wood vines covering tall trees as sleeping sites is common among the callitrichid monkeys living in the upper Amazon basin.

The fact that the author has never received information from inhabitants to suggest that *Callimico* sleeps at particular sites such as hollows in trees, may constitute further circumstantial evidence of this.

Movements: Moynihan (1976a) reported that *Callimico* "clings to tree trunk in vertical position, and often leaps or hops from trunk to trunk with the body and head kept upright." According to information obtained in the Río Blanco in Perú also, *Callimico* usually remains in the lower layer of the forest, almost on the ground to about 3 m above ground level, and sometimes descends to the ground. On noticing a

Fig. 4. A wild *Callimico* of the Arroyo Buenos Aires, Bolivia.

human approach, it runs away leaping from trunk to trunk, stations itself behind a tree trunk, or lands to hide itself in the under-growth. In any case, it is difficult to locate *Callimico* in forest, although it is said that the presence of a dog facilitates searches for *Callimico* inasmuch as dogs tend to chase the monkey up into trees.

The author was informed in Bolivia that whenever it is forced to run away, *Callimico* leaps horizontally, not straight but in a zigzag, with the body and head kept upright, at the height of the human eye or above. He was also told that it occasionally jumped down to the ground and then escaped. One escape by *Callimico* observed by the author was also made in rapid horizontal zigzag leaps at a height of about 2 m above the ground.

The author once observed *Callimico* moving around in the early morning (Fig. 4). It repeated a sequence of feeding in a tree, descending along the trunk to a height of 1.5–2.5 m, leaping from trunk to trunk to seek for another suitable tree, and resuming feeding in the tree. It was also observed that after quadrupedally running on a branch to the tip, *Callimico* jumped onto an adjoining tree in order to move on. However, the former manner of progression was seen far more frequently than the latter. It is noticeably different from that taken by other callitrichids observed by the author in the upper Amazon basin, e.g., *Cebuella, S. nigricollis, S. mystax, S. fuscicollis,* and *S. labiatus.*

Group size: Hershkovitz (1977) reported that *Callimico* travels "perhaps only in pairs or small family unit, consisting of parents and one young." Also, the information given to the author in Colombia, Perú, and Bolivia suggested that *Callimico* lived in a small group consisting of no more than five individuals. On the other hand, the author did estimate the number of individuals in one group of *Callimico* at Drs. Pook's study site as seven and Drs. Pook have given the number as six to eight (pers. comm.).

According to data on *Callimico* in captivity cited by Hershkovitz (1977) and to data obtained at the Japan Monkey Centre, where an adult female gave birth on January

15, 1976, had a miscarriage on October 11, 1977, gave birth on March 30, 1978, was observed to mate on April 5, 1978, gave birth again on October 6, 1978, and gave the birth on March 28, 1979, a possibility exists that *Callimico* can give birth twice a year even in the wild. If this is true, it may well be that one group of 7–8 individuals represent a pair typed group.

Finally, if the main food of *Callimico* is insects living in the under-layer of the forest and fruit of scrubs, it would appear that "shabby" forest, its habitat, is better suited to it than a typical Amazonian tropical rain forest. Possible sleeping sites for *Callimico* would also occur everywhere in the "shabby" forest. It can also be said that the manner of movement, i.e., horizontal zigzag leaping, is well suited to the vegetation of the "shabby" forest; it may represent an adaptational character inasmuch as it could permit avoidance of predation by both small-sized carnivora on the ground and rapacious birds in the sky.

No noticeable regional differences in the ecology of *Callimico* have yet been recorded.

Distribution of *Cebuella*

In the above-mentioned survey in the Río Caquetá basin, the author directly observed *Cebuella* at Pto. Limón near Mocoa, in the lower Río Sencella basin, the middle and lower Quebrada de La Tagua basins, and on the Río Caquetá about 5 km downstream from La Tagua. All of these localities are on the south bank of the Río Caquetá. He also obtained information suggesting its occurrence as far as the riverside of the Río Caquetá from Pto. Limón to Araracuara. On the other hand, *Cebuella* was not confirmed to inhabit the north bank of the Río Caquetá, although the author did confirm that it inhabited a small island in the Río Caquetá about 1 km downstream from Pto. Limón. He also received information that *Cebuella* appeared to live in the Río Pacayaco basin, which is a little lower than Pto. Limón.

The reliability of all the information obtained has not been confirmed by the author, but it may be true that the northern limit of the distribution of *Cebuella* coincides not with the main stream of the Río Caquetá in its upper basin but with the Río Orteguaza.

Hershkovitz (1977) has published two maps on the distribution of *Cebuella* (Hershkovitz, 1977, Figs. VII.1, VIII.1). Judging from the former figure, the northern limit in the upper Río Caquetá basin coincides with the Río Orteguaza, while the latter figure shows it to be the main stream of the Río Caquetá.

According to Hernandez-Camacho and Cooper (1976), *Cebuella* borders the Río Caquetá in the north. But they also gave information on a captive specimen in Canõ Morrocoy of the Río Guayabero, further north of the Río Caquetá. However, during his stay there covering a total of more than six months from 1975 to 1978, the author was unable to obtain any information on the occurrence of *Cebuella* there.

Concerning the southern limit of distribution of *Cebuella*, it can be said from the above-mentioned survey in northern Bolivia that *Cebuella* borders the Río Orthon-Río Manuripi in the south, although there was one unreliable suggestion that it might occur near Pto. Rico like *Callimico*. The southern limit deduced by the author is located further south than that (the Río Purús) reported by Hershkovitz (1977).

From the above data, it can be said that *Callimico* and *Cebuella* inhabit almost

completely the same range.

Pattern of distribution of *Cebuella*

Cebuella inhabits the above range in far greater numbers than *Callimico*. However, it is a less common monkey than each species of *Saguinus*.

All the localities where the author directly observed *Cebuella* in Colombia were situated in second-growth woods near farm-houses or adjoining plantations and ranches. Most of the localities given in information on its occurrence on the south bank of the Río Caquetá or the upper Río Putumayo basin were situated in similar second-growth woods and sometimes in flooding forest. Inhabitants of the Río Caquetá and Río Putumayo basins also informed the author that *Cebuella* inhabited only the second-growth woods or forest edges and added that they had rarely encountered it inland away from the rivers. On the other hand, Hernandez-Camacho and Cooper (1976) stated that "*Cebuella* is typically an inhabitant of mature, non-flooding forest." The author disagrees with this conclusion. They reported that *Cebuella* is "rather difficult to find due to their small size, the camouflage of their coat color, their squirrel-like habit of moving to the opposite side of trunk when disturbed, and their lack of any conspicuous physical or vocal display." However, this analysis may be faulty like Hershkovitz' (1977) statements regarding the difficulty in finding *Callimico*. It is impossible to believe that the above features would disturb leading primate-ecologists from finding *Cebuella*. Native hunters can capture it very easily, and they have guided the author to localities inhabited by *Cebuella* where he was able to observe it directly. All of the hunters know that *Cebuella* has a peculiar feeding habit, as described later, so that tree trunks in its inhabiting area have noticeable feeding prints. The hunters informed the author that they had rarely seen even such feeding prints in localities away from the rivers.

Moynihan (1976b) stated that "It is not possible to determine the original habitat preference of pygmy marmosets. They may well have occurred along edges of forests," and added that "They seem most abundant in 'hedges,' strips and clumps of degraded woods found between pastures and crop fields from which the most economically valuable (tallest) trees have been removed by selective cutting and from which many of the larger mammals have been driven by hunting."

In Perú, Mr. P. Soini has been studying over ten groups of *Cebuella* for years in the Río Manití basin downstream from Iquitos. When the author visited him, he was told that *Cebuella* did not necessarily live in the second-growth woods adjoining farm-houses or plantations or in flooding forest by the rivers (pers. comm.). However, some dozen groups actually lived in the flooding forest along the Río Manití or in second-growth woods adjoining the farm-houses. Even during his extensive surveys around Iquitos, Mr. Soini had rarely encountered *Cebuella* in mature forest located inland where neither farm-houses nor plantations were found (pers. comm.). The author also obtained information during surveys in the basins of the Río Tapiche and Río Blanco that *Cebuella* inhabited the riverside of the Río Tapiche. Moreover, in the flooding forest at the confluence of the Río Tapiche and Río Blanco (Fig. 5), the author encountered it (Izawa, 1978b). However, in the upper Río Blanco basin, which *Callimico* was said to inhabit, the inhabitants informed the author definitively that *Cebuella* did not occur.

In northern Bolivia, *Cebuella* is called "taboca," which is a vernacular name for a kind of bamboo, *Bambusa* sp. The name may thus be derived from the fact that it prefers to live in the bamboo forest. The author made direct observation of *Cebuella* in the Río Nareuda basin, the locality being in the second-growth woods adjoining farmlands (Izawa, 1979a, b). Inhabitants of this area informed him that apart from the bamboo forest or second-growth woods, *Cebuella* did not occur in the inland mature forest. In fact, the author was unable to find any tree trunks with feeding prints.

Based on the above-mentioned data, it can be said that *Cebuella* is less rare than *Callimico* and lives as a substantial population in second-growth woods adjoining farm-houses or plantations, in forest having well-developed scrub, or in flooding forest on the forest edges. The habit of *Cebuella* is "shabby" forest like that of *Callimico*. However, compared to *Callimico*, which occupies the "shabby" forest of the inland areas, *Cebuella* inhabits the "shabby" forest on the forest edges (Figs. 6a, b, c).

Ecology of *Cebuella*

Details of the feeding habits of *Cebuella* have been studied by Mr. P. Soini (pers. comm.). According to him, its main food is sap which oozes from trees, as reported also by Izawa (1975), Moynihan (1976a, b), and Hernandez-Camacho and Cooper (1976). Mr. Soini informed the author that besides such sap, *Cebuella* eats fruit and insects (pers. comm.), and the author himself observed *Cebuella* eating also fruit of *Cecropia* and grasshoppers at Mr. Soini's study site in the Río Manití basin (Izawa, 1977a, b). Mr. Soini also said that the home range of each group of *Cebuella* which he observed was small on average (0.2–0.3 ha) and contained 3–4 sap trees (pers. comm.). It may be difficult for *Cebuella* to secure a constant supply of fruit and insects in such a small limited range. Accordingly, when one views *Cebuella* throughout the year, it appears that *Cebuella* may be specialized as a sap eater: *Cebuella* makes holes in tree trunks and branches and eats mainly sap which oozes from them. This was true for *Cebuella* observed by the author in Bolivia (Izawa, 1979b).

Fig. 5. Flooding forest, a kind of "shabby" forest, at the confluence of the Río Tapiche and Río Blanco, Perú.

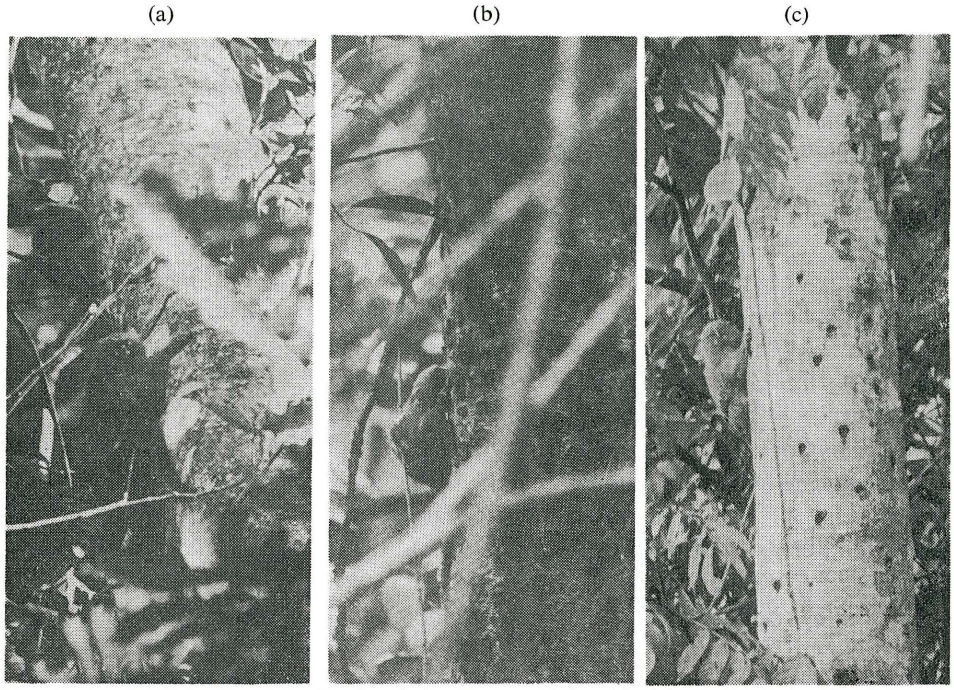

Fig. 6. A wild *Cebuella* of the Quebrada La Tagua, Colombia (a), a wild *Cebuella* of the Río Manití, Perú (b), and a wild *Cebuella* of the Río Nareuda, Bolivia (c).

In Colombia, *Cebuella* sleeps in holes in trees (Moynihan, 1976a, b), and the animals observed by the author in Quebrada de La Tagua did so. Information from inhabitants in the vicinity of La Tagua also confirmed this trait. In Perú and Bolivia, the author observed *Cebuella* sleeping in the foliage of wood vines covering trees, like *Callimico*. Mr. P. Soini also provided him similar information.

On noticing a human approach, *Cebuella*, unlike *Callimico*, hides itself rapidly or slowly as if crawling to the opposite side of a trunk. When moving in forest, it usually runs and crawls on branches or wood vines, jumps onto discontinuant branches, and goes up and down tree trunks. Occasionally it leaps from tree to tree. *Cebuella* remains in the lower layer of the forest almost all day long.

Assuming that *Cebuella* is able to avoid predation by both small-sized carnivora on the ground and rapacious birds in the sky, it might be said that the above-mentioned findings represent adaptive behavior and ecology to "shabby" forest.

After describing characteristics of movements of *Cebuella*, Moynihan (1976b) also stated that "When individuals pass from one tree to another, they almost always prefer to take a low route rather than a high one, thus keeping as far as possible from canopy and minimizing exposure to flying birds of prey."

Pattern of distribution of *Saguinus*

It is important to consider why *Callimico* inhabits and is adapted to the "shabby" forest of more inland areas, whereas *Cebuella* occupies the forest edge.

However, the author will first describe the distribution of *Saguinus* which overlaps with that of *Callimico* and *Cebuella*. *Saguinus* includes five species, i.e., *S. nigricollis,*

S. mystax, S. imperator, S. labiatus, and *S. fuscicollis.* They inhabit each range as a high population, no matter whether it is in mature forest or in "shabby" forest, or in inland areas or on the forest edge, and are rather common species of monkeys.

Their main foods consist equally of insects and fruit (Izawa, 1978a, 1979b; Mr. P. Soini, pers. comm.). The mode of movements are various. When escaping from human beings, they tend to utilize a mixture of movements such as vertical climbing on large tree trunks, running or crawling on branches, hopping from treetop to treetop, leaping from trunk to trunk, etc.

Compared to ceboids which occur sympatrically with *Saguinus*, there are differences in habitat. The ceboids chiefly utilize the forest canopies, whereas *Saguinus* occupies the lower layer of the forest. However, it is rather difficult to identify peculiar differences in the habitat of *Saguinus*, in contrast to *Callimico* and *Cebuella*, which both tend to utilize only a special type of forest in the tropical forests.

Hershkovitz (1977) has proposed a hypothesis for the phylogenetic evolution of callitrichids, mainly based on bleaching theory for body color. According to him, the above five species can be ranked as a "hairy-face tamarin section" when compared to other callitrichids, and this section is divided into two groups, a "*Saguinus nigricollis* group" and a "*Saguinus mystax* group."

Four of the species inhabit the upper Amazon basin: they are, from north to south, *S. nigricollis, S. mystax, S. imperator,* and *S. labiatus*. The author has not studied any bordering areas between these ranges, but the results and information obtained indicate that each of the above four species inhabits allomatrically. Hershkovitz (1977) gave maps (Hershkovitz, 1970, Figs. X.21, X.30, X.38) showing that *nigricollis* and *mystax, mystax* and *imperator,* and *imperator* and *labiatus* did not have overlapping distribution ranges, whereas *nigricollis* and *labiatus,* and *mystax* and *labiatus* had somewhat overlapping ranges. These maps do not show directly that two species each whose ranges overlap with each other occur sympatrically. However, there is a good possibility that any one of the above pairs may inhabit sympatrically in a limited locality (Mr. P. Soini, pers, comm.).

On the other hand, *S. fuscicollis*, which is categorized as belonging to the "*Saguinus nigricollis* group," largely overlaps in its distribution range with the four above species, and inhabits sympatrically with any one of them. Furthermore, *fuscicollis* and each species of monkey which inhabits sympatrically with it, frequently form mixed groups during their daily lives. All the species of *Saguinus* utilize the lower layer of the forest relatively frequently in comparison with ceboids which utilize forest canopies. However, some apparently different tendencies exist between the two components of such pairs. For example, both in cases observed by the author, combinations of *mystax* and *fuscicollis,* and of *labiatus* and *fuscicollis,* and in cases observed by Mr. P. Soini, combinations of *mystax* and *fuscicollis,* of *nigricollis* and *fuscicollis,* and of *imperator* and *fuscicollis* (pers. comm.), the former of each pair utilizes the upper part of the lower layer of the forest relatively frequently, whereas the latter utilizes its lower part relatively frequently.

Hershkovitz (1977) divided the above five species into the two groups according to their morphological characteristics. However, considering their distribution and ecology, the author prefers simply to separate *fuscicollis* from the other four species. Should such a categorization be valid, *fuscicollis* must have diverged at the northern

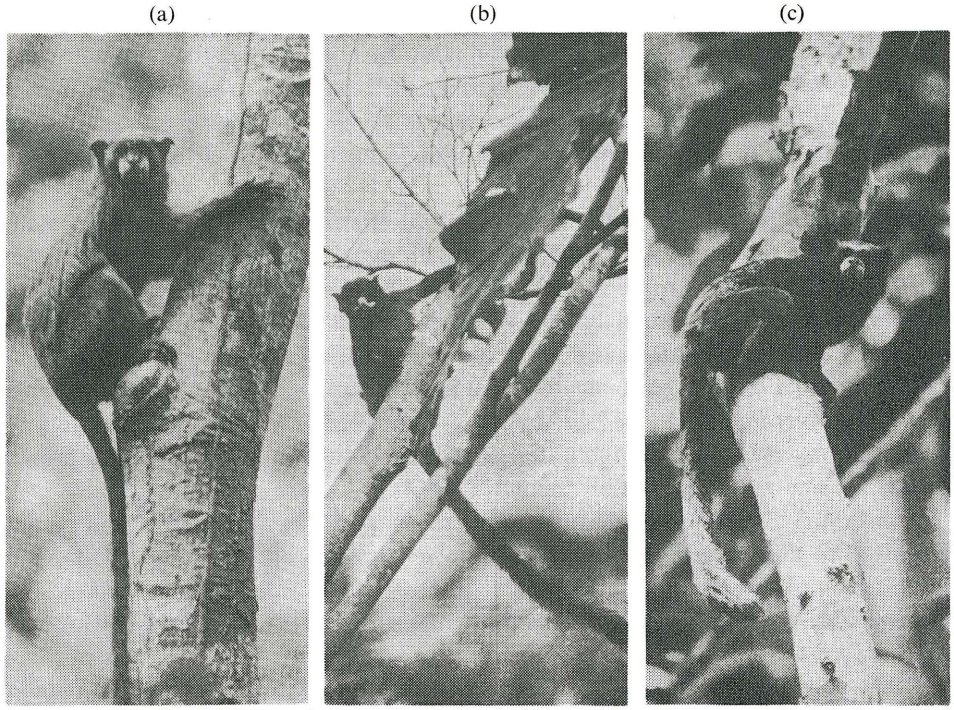

Fig. 7. A wild *S. nigricollis* of the Río Peneya, Colombia (a), a wild *S. labiatus* of the Río Nareuda, Bolivia (b), and a wild *S. fuscicollis* of the Río Nareuda, Bolivia (c).

part of the upper Amazon basin, based on the bleaching theory mentioned by Hershkovitz (1977). It then becomes possible to regard *fuscicollis* as derived from *nigricollis* (a colony of prototype of *nigricollis*), which is a member of the other group distinguished by the author, and *fuscicollis* would later have enlarged its distribution rapidly southward.

Concerning the localities which the author was informed that *Callimico* inhabited, there was a high possibility that *nigricollis* also occurred Quebrada del Hacha and *mystax* in the upper Río Blanco basin: both of these localities lacked *fuscicollis*. The author has obtained other similar information elsewhere, but confirmation is neces sary.

There have been few such studies so far. In northern Bolivia, the author observed that *labiatus* and *fuscicollis* sympatrically inhabited localities where *Callimico* occurred. In the Río Guineo basin, Moynihan (1976a) observed that *nigricollis* and *fuscicollis* inhabited sympatrically with *Callimico*. However, should the relation between *fuscicollis* and the other four species of *Saguinus* living in all localities inhabited by *Callimico* be studied in detail, it may well emerge that the inhabiting area of *Callimico*, especially in the central to northern part, lacks one or other component of a pair of species of *Saguinus* with a rather high probability, and that *fuscicollis* is the missing component with a rather high probability (Figs. 7a, b, c).

Present state of the relationships between *Callimico* and other animals

Callimico and *Cebuella* completely overlap each other in their distribution ranges.

It is true that both sympatrically inhabit some localities (e.g., northern Bolivia), but there is also ample possibility that they inhabit many other localities allomatrically, as mentioned above. In other words, viewing their patterns of distribution macroscopically, it can be said that *Callimico* and *Cebuella* are segregated, the former occurring in the"shabby" forest of more inland areas and the latter in that of the forest edges.

The author has never received the information to suggest that *Callimico* and *Cebuella* form mixed groups with each other in particular localities where they inhabit sympatrically. They have not been reported to form mixed groups with each other in any other localities, either. Viewing their patterns of distribution microscopically even in localities where both live sympatrically, it can again be said that *Callimico* and *Cebuella* are segregated from each other in various ways. For example, the former lives in continuing "shabby" forest, the vegetation of which has been left untouched by man, whereas the latter lives in the human-influenced second-growth woods, or small dotted areas of "shabby" forest.

Concerning *Callimico* and *Saguinus,* one or two species of the latter inhabit sympatrically with *Callimico* in many localities. However, when one views their patterns of distribution macroscopically, it is possible to grasp that *Callimico* (and *Cebuella*) and *Saguinus* are segregated, the former occurring in "shabby" forest and the latter in mature forest.

It has been found that *Callimico* forms mixed groups with any one of *S. labiatus, S. fuscicollis,* or *S. nigricollis,* which inhabit sympatrically with *Callimico* (Moynihan, 1976a; Mr. P. Soini, pers. comm.; Dr. G. Pook, pers. comm.). The author has also received information from local inhabitants that *Callimico* forms mixed groups with some other species of *Saguinus.* (It is not known that *Cebuella* and *Saguinus* form mixed groups with each other.) However, from the author's survey in northern Bolivia, it seems possible that habitat segregation exists to some extent between *Callimico* (and *Cebuella*) and *Saguinus*, since the former clings to life in the "shabby" forest, whereas the latter, although utilizing the "shabby" forest, is never attached to it.

The question then arises as to how *Callimico* is related with ceboids monkeys. Among the species of ceboids monkeys, *Cebus, Saimiri, Callicebus, Cacajao* and *Aotus* utilize the "shabby" forest where *Callimico* occurs. However, there is no evidence to suggest that *Callimico* and each of the ceboid monkeys are segregated from each other in any more specialized ways than *Callimico* and some callitrichid monkeys, and ceboids are macroscopically segregated from each other: the former two inhabit the more lower part of the forest, while the latter occurs the forest canopies. Furthermore, it seems unlikely that any one of the above ceboid monkeys occurring sympatrically with *Callimico* plays a role as competitor influencing the life of *Callimico* more severely than the callitrichid monkeys mentioned above. As possible competitors to *Callimico*, small body- sized arboreal mammals such as squirrels (*Sciurus* and *Microsciurus*) and small birds deserve closer consideration. Comparative ecological studies of *Callimico* and these animals have not yet been made. However, the author does not anticipate that small body-sized arboreal mammals are very strong competitors to *Callimico* since his surveys have disclosed that such mammals occur at lower population densities in any localities so far observed.

Accurate data are not yet available on predators of *Callimico.*

Phylogenetic and evolutionary relationships between *Callimico* and callitrichid monkeys

Hershkovitz (1977) suggested that the Callitrichidae and Callimiconidae diverged first from some ancestral platyrrhine stock and then *Cebuella, Leontopithecus, Callitrix,* and *Saguinus* were sequentially derived from the Callitrichidae (Hershkovitz, 1977, Fig. VII. 3). He indicated hypothetical directions for callitrichid dispersal and geographic differentiation (Hershkovitz, 1977, Fig. VII. 4). He also considered that the triangle of the upper Amazon basin surrounded by the Río Caquetá, Río Purús, and Andean foothills represented the "early-, or pre-Quaternary relict or refuge zone," (which was spared from destruction of forest habitats by protracted floods or droughts) "and prime or possible centers of origin of modern callitrichid genera, species groups and *Callimico.*"

Since it is not vital to the main subject of the present paper, the author does not intend to discuss in detail the question of whether the Callimiconidae should be dealt with independently as supposed by Hill (1957) and Hershkovitz (1977), or whether *Callimico* should be included in the Callitrichidae (Napier & Napier, 1967), or Cebidae (Simons, 1972). Even so, the author is confident that *Callimico* and *Cebuella* diverged earlier than the other modern callitrichid genera as Hershkovitz (1977) supposed.

On the other hand, according to Gibbs (1967), the present triangle of land surrounded by the Río Caquetá, Río Madeira, and Andean foothills may correspond to a large lake during the Tertiary after the uplift of the Andes mountains, and when an outlet from the lake appeared in the east (the Río Amazonas), the area may have gradually changed to forest. If this is true, it is presumed that a mature forest such as is seen today was not present in the upper Amazon basin in early and middle Quaternary, while certain kinds of "shabby" forests were largely found around the lake and on islands in the lake. *Callimico* and *Cebuella* may have become ecologically and behaviorally adapted to live in such forests and co-existed by means of habitat segregation in the "shabby" forest, one in more inland area, and the other on the lake side.

By and by the forest began to develop. *Saguinus* may then have advanced into the upper Amazon basin from the southeast with the development of forest and rapidly enlarged its range. [Its advancement from the southeast comes from Hershkovitz (1977).] *Saguinus* may have utilized positively both the developed forest and the still remaining "shabby" forest. However, macroscopically *Saguinus* may have segregated from *Callimico* and *Cebuella*: the former possibly inhabited the recovered forest and the latter the "shabby" forest. Microscopically it may have segregated from both: one utilized either the upper or lower part of the forest more frequently than the other, as in the habitat segregation observed today between *fuscicollis* and *nigricollis, mystax,* and *labiatus.*

As the forest developed more completely and the "shabby" forest became fragmented and reduced in size, so the distribution of *Callimico* and *Cebuella* may also have become fragmented and reduced. When the forest was more or less fully developed, a speciation was made in *Saguinus,* and *fuscicollis* group may then have been arisen. Contrary to the *Saguinus* (i.e., *labiatus, imperator, mystax,* and *nigricollis*) before the speciation, which enlarged its range northward, *fuscicollis* may have originated in the

north and advanced southward to enlarge its range. The four species of *Saguinus* and the new *fuscicollis* may have co-existed by means of habitat segregation, the former utilizing the upper part of the forest more frequently and the latter tending to occupy the lower part of the forest.

However, the appearance of *fuscicollis* and enlargement of its range may have provoked competitive relationships with *Callimico* and *Cebuella*. The reduction in size of the "shabby" forest with such competition with *fuscicollis* may then have caused decisive damage to *Callimico* and *Cebuella*. *Cebuella,* however, may have been less damaged than *Callimico* since it could utilize the flooding forest on the forest edges as one of its habitats. Moreover, a rapid increase in second-growth woods on the forest edges following man's advance into the upper Amazon basin may have made it possible in cooperation with its ecological and behavioral peculiarities that *Cebuella* recovered its population.

On the other hand, regarding *Callimico*, is it impossible to say that as if being drifted by the *fuscicollis'* pressures from the north, *Callimico* can barely maintain a relatively larger population in the "shabby" forest located in northern Bolivia, the southern limit of its range, than in the other areas? If it is possible to say so, it can be safely said that from the phylogenetic evolutionary viewpoints, *Callimico* may be destined to become extinct because of two factors such as unartiffcial, that it, geographical decline of the "shabby" forest and the competitive relationships with *Saguinus*, especially *S. fuscicollis*.

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